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STANDARD FAMILY OF POWER SOURCES

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STANDARD FAMILY OF POWER SOURCES

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JULY 1970

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US ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY

ABSTRACT

A standard family of power sources is proposed which will minimize the number and variety of power sources, prevent the flooding of the supply system with hardware that only could be used in a single application and provide the user with a family of power sources from which he could select one suitable to meet the needs of his equipment.

This standard family incorporates the use of standard output voltages (6/12/24 volts), a standard connector which provides electric interchangeability and standard dimensions which provide physical interchangeability. The use of the standard family achieves a new concept in the deployment of power sources. No longer is a single power source developed for each equipment; rather, the selection of a battery is based on the mission requirement, the user selecting the most satisfactory battery for the particular deployment of his equipment.

A list of power sources, including batteries, fuel cells, thermal energy generators, and power supplies being developed as part of the standard family, is included in the report.

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STANDARD FAMILY OF POWER SOURCES

INTRODUCTION

The standardization of power sources for military equipment is essential to minimize the number and variety of power sources, to prevent the flooding of the supply system with hardware that only could be used in a single application and to provide the user with a family of power sources from which he could select one suitable to meet the needs of his equipment.

A program for the standardization of portable power sources has been established at USAECOM which is applicable and common to all types of batteries, fuel cells, generators and power supplies. This program gives the user the flexibility of selecting the most desirable power source for his needs, the ability to interchange power sources and incorporate advanced power source designs without any retrofitting of his equipment. At the same time, it eliminates the proliferation of power sources developed for specific uses and reduces the need for separate power source development for each new equipment development.

The main features of the standard family are:

(1) The use of standard output voltages (6, 12, 24 volts).

(2) The use of a standard input/output connector receptacle.

(3) The design of the standard family in selected physical configuration or "building blocks."

(4) The interchangeability between power sources.

(5) The applicability of the design concept to all portable power sources.

MAIN FEATURES

Standard Output Voltage (6, 12, 24 Volts)

The heart of the standard family of power sources is the use of standard output voltages and the limiting of these to only three different voltages. The voltages selected were 6, 12 and 24 volts dc (nominal) with the 24 volt output being preferred to obtain compatibility with vehicular power sources.

Limiting the number of standard voltages has been found to cause little or no hardship to the equipment engineer as he can control his design to accommodate these voltages. It is a key element in the concept of standardization to control the variety of power sources and obtain multiple use for each of the power sources in the family.

Single Connector/Receptacle Compatibility

A single six pin output receptacle is used on the power sources in the standard family to attain complete interchangeability and provide the proper output voltage. This receptacle is shown on a battery in Figure 1. The wiring arrangement to this connector is detailed in Figure 2. All batteries are connected in two sections with two sets of leads brought up to the connector. Thus, 12/24 volt batteries are wired as two 12 volt sections. The equipment connector is wired to series or parallel these sections to provide 24 or 12 volt output, or to use each 12 volt section as an independent power source. Similarly, the 6/12 volt battery is wired for 6 or 12 volts.

An important advantage of this connector system is the prevention of voltage mismatching. It can be seen from Figure 2 that the equipment is protected if it is connected to a battery of improper voltage. If, for example, an equipment requiring 6 volts is connected to a six or 6/12 volt battery, the equipment will see 6 volts. However, if the 6 volt equipment is erroneously connected to a 12/24 volt battery containing two 12 volt sections, no voltage is applied to the equipment and no harm can be done. The same protection applies for a 24 volt equipment connector plugging into a 6 volt battery or any other mismatching.

The battery receptacle (described in USAECOM Technical Requirement SCL-6028)[1] is available in two versions; an inexpensive plastic molded receptacle for primary disposable batteries (Figure 3) and the permanent receptacle used in storage batteries and other power supplies which are used repetitively and have long term use. Suitable male connectors and connecting cables for 6, 12 and 24 volt equipments are available. Details of these devices also are described in SCL-6028.

Physical Interchangeability

The standard family of power sources is designed to provide physical interchangeability between power sources and equipment in order to achieve flexibility and the maximum use of each power source. This is accomplished by using two basic configurations, identified as Type I (manpack) and Type II (man-portable) and by building all standard family power sources in these configurations. The designations "Type I" and "Type II" depict the interface cross-section, or footprint dimension of the power source and user equipment. The height of the power source is varied, depending on the voltage and energy rating and the type of power source employed.

The advantage of these set physical dimensions is that all equipment designed to the standard interface will mate physically and electrically with an appropriate member of the standard family of power sources. Thus, the power sources most suitable for a given mission can be selected rather than one which was uniquely designed for only one equipment.

The Type I manpack design has a footprint dimension of 4" x 12" as shown in the interface control drawing of Figure 4. View A-A shows the interface dimensions of the battery of Type I power source and view B-B

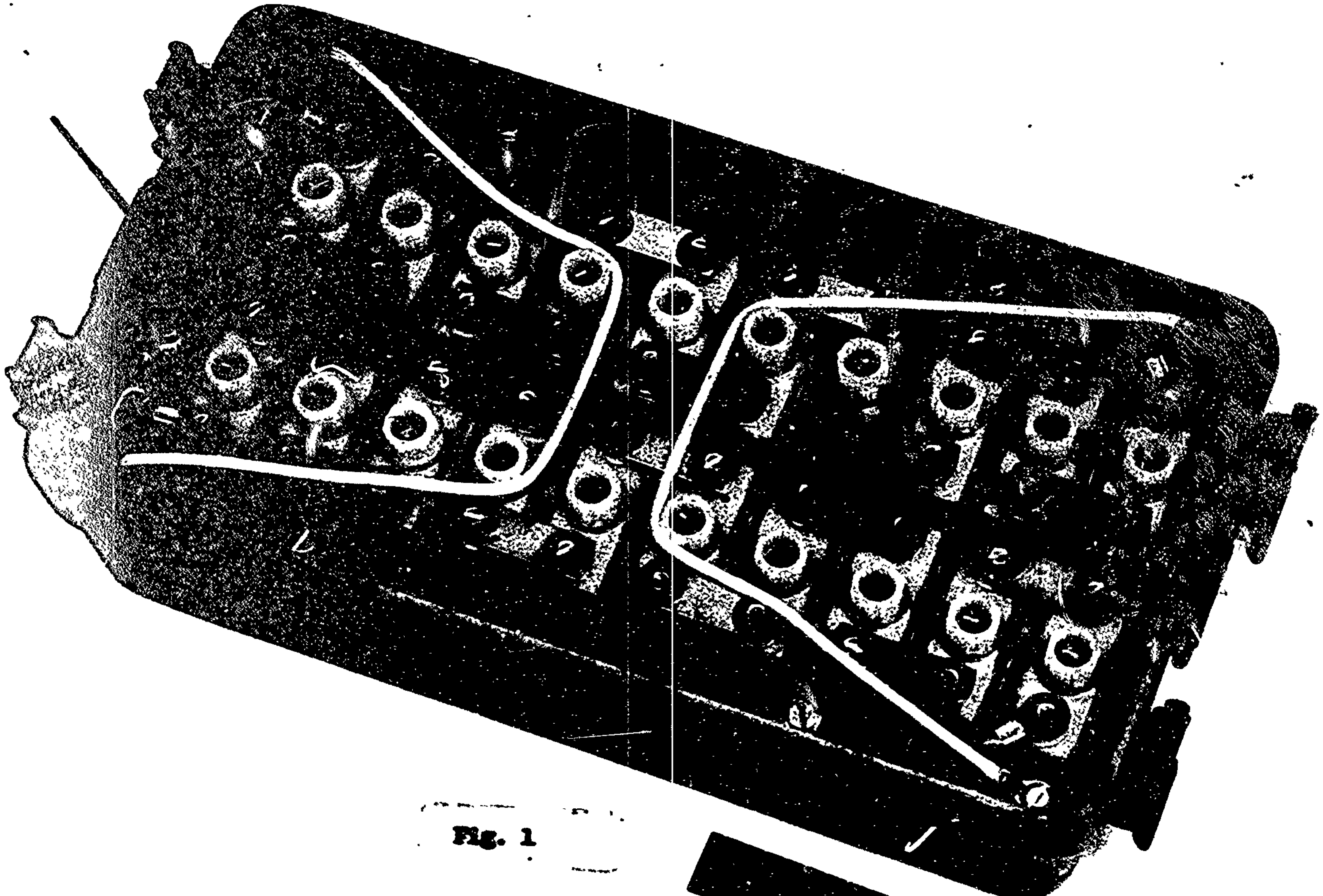


Fig. 1

WIRING ARRANGEMENT

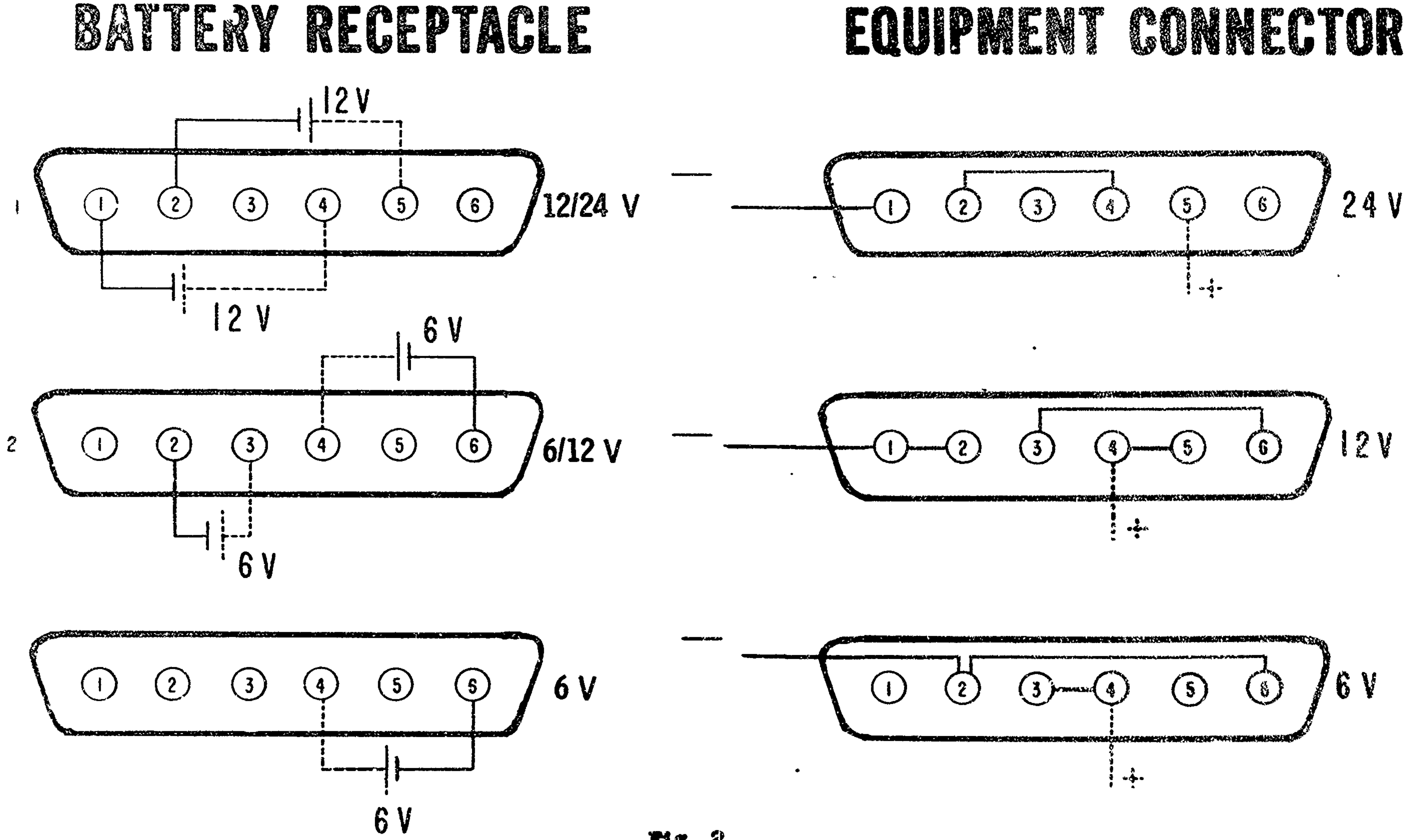


Fig. 2

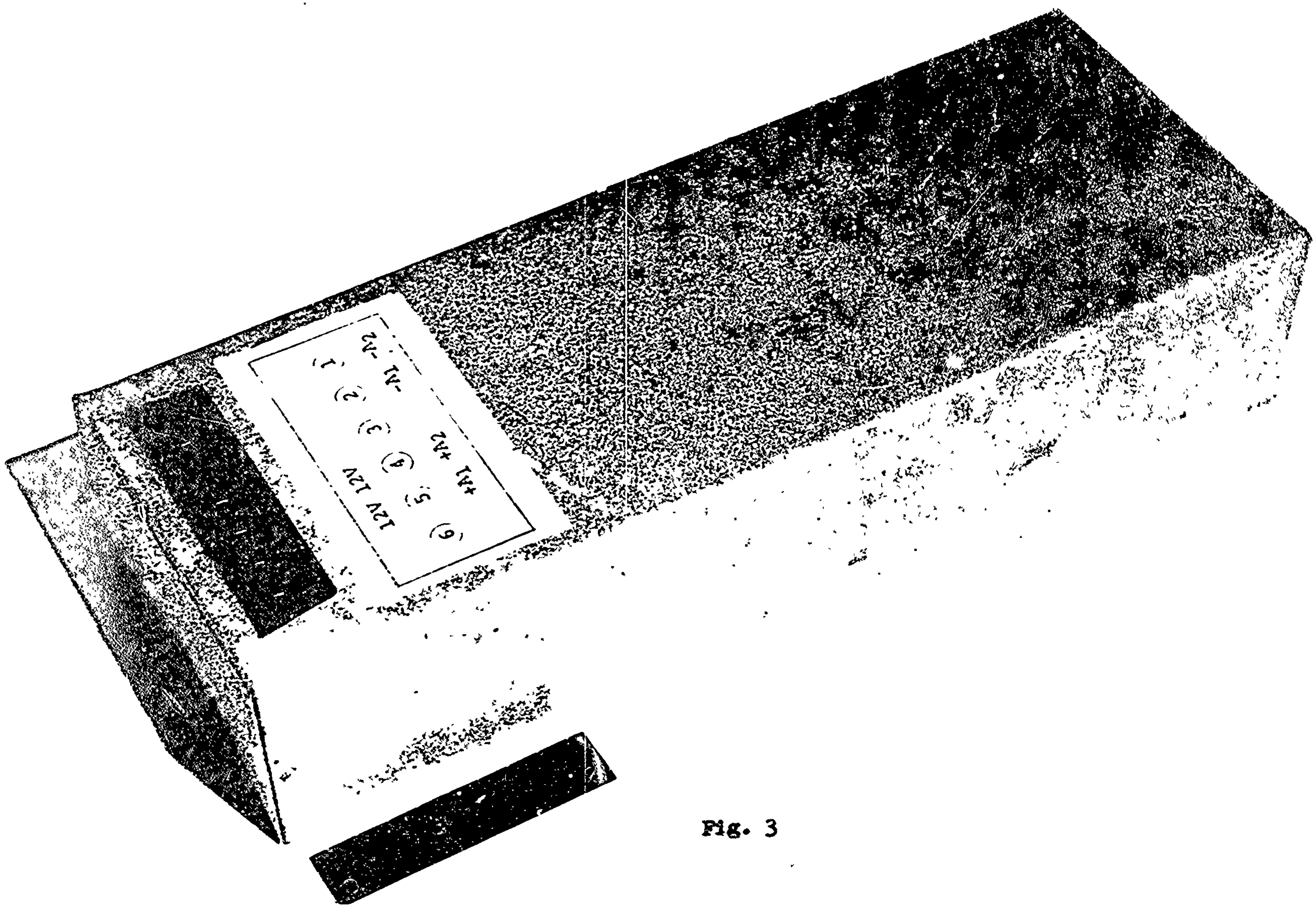


Fig. 3

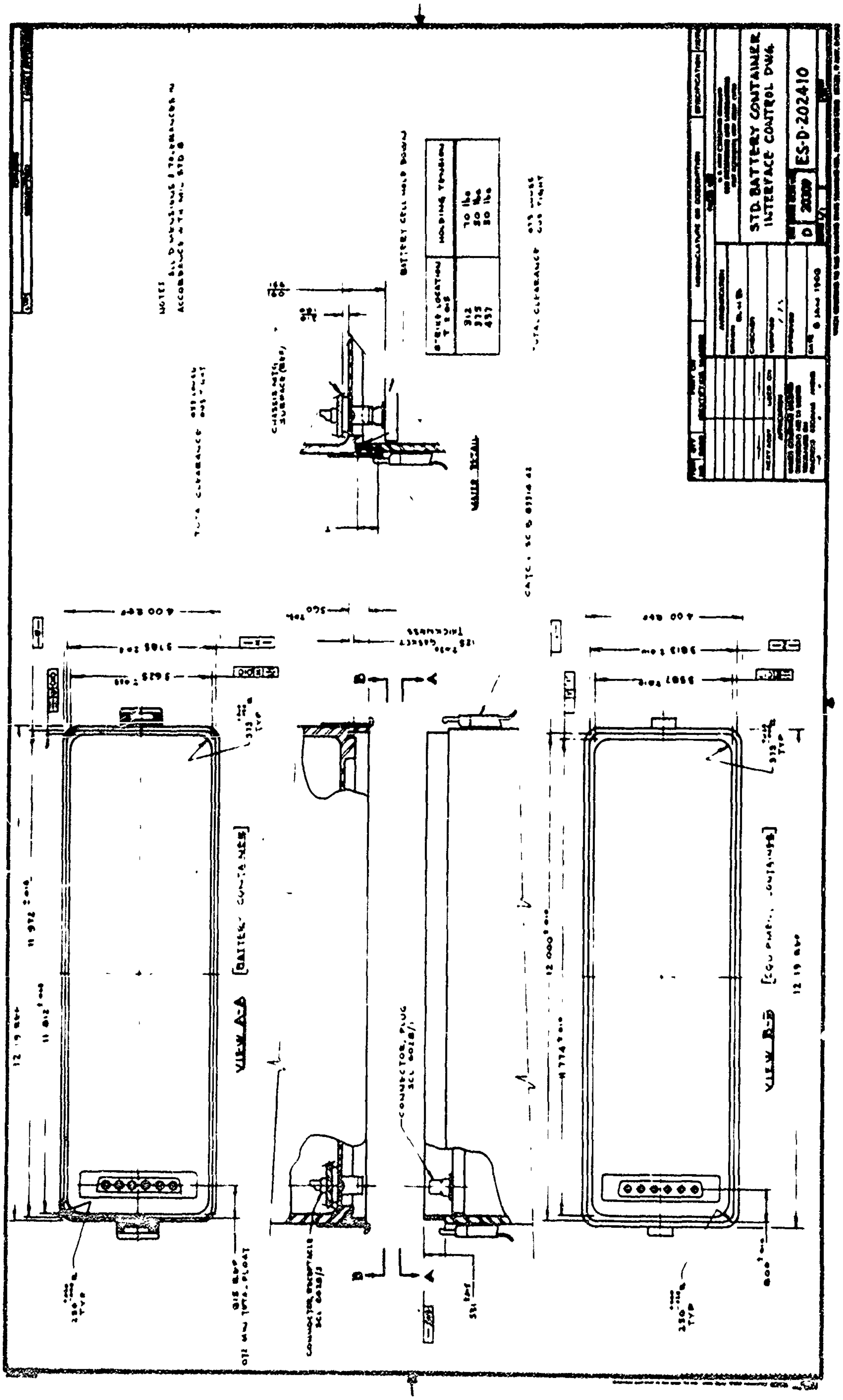

STD. BATTERY CONTAINER
INTERFACE CONTROL DWG
ES-D-202410
VIEW A-A [BATTERY CONTAINER]
VIEW B-B [EQUIPMENT CONTAINER]
HOLDING TENSION
70 lbs
30 lbs
30 lbs

Fig. 4

shows the underside of the equipment container. The power source and user equipment are mated directly, eliminating the use of an interconnecting cable and providing a watertight seal at the interface when the user equipment is placed on top of the power source. An additional advantage acquired from this mating procedure is the elimination of power losses by an interconnecting cable.

The Type II design, which has a cross-section of 6-3/4" x 12", is shown in Figure 5 and is used in a similar manner as the Type I configuration.

Figure 6 illustrates a hybrid manpack Type I power source and shows the flexibility of this approach. The system consists of a secondary battery on the bottom, a silent fuel cell in the middle and a portable radio on top. The hybrid combination of fuel cell and battery provides the lightest weight system for moderate to long term operation of the radio set. For remote area patrol duty, where only short term operation is required and where weight is a critical factor, the fuel cell can be eliminated and the radio set can be operated directly from the battery, or other suitable power source without requiring any electrical, mechanical or physical modification or adjustment.

Several of the power sources in the standard family, particularly the larger fuel cells and thermoelectric generators, do not lend themselves to Type I or Type II configurations. Similarly, some equipments cannot be designed to these set dimensions. Although such equipments cannot physically interface with the appropriate power sources, they can be electrically compatible through use of the standard connector/receptacle and the proper cable.

In addition, it is likely that future miniaturization of electronic equipment will make it desirable to standardize on a configuration with a smaller cross-section than Type I. This will be considered as soon as such requirements materialize.

Applicability to all Types of Power Sources

Ideally, it would be desirable if a single battery system or power generator could handle all military requirements. However, as no one system is superior in all respects for all types of applications, it is necessary to utilize a number of different power sources - each having certain advantageous characteristics for a particular use. This is illustrated in Figure 7. The requirement of power level is plotted against operating time and the most effective portable power source for the different types of use is shown in the matrix. It is seen that special batteries are used to best handle the short time requirements of fuzes and missiles. Secondary batteries are best in applications up to about one (1) hour. Conventional primary batteries and metal-air batteries are employed up to 20-50 hours and the thermoelectric generators and fuel cells for long operating times.

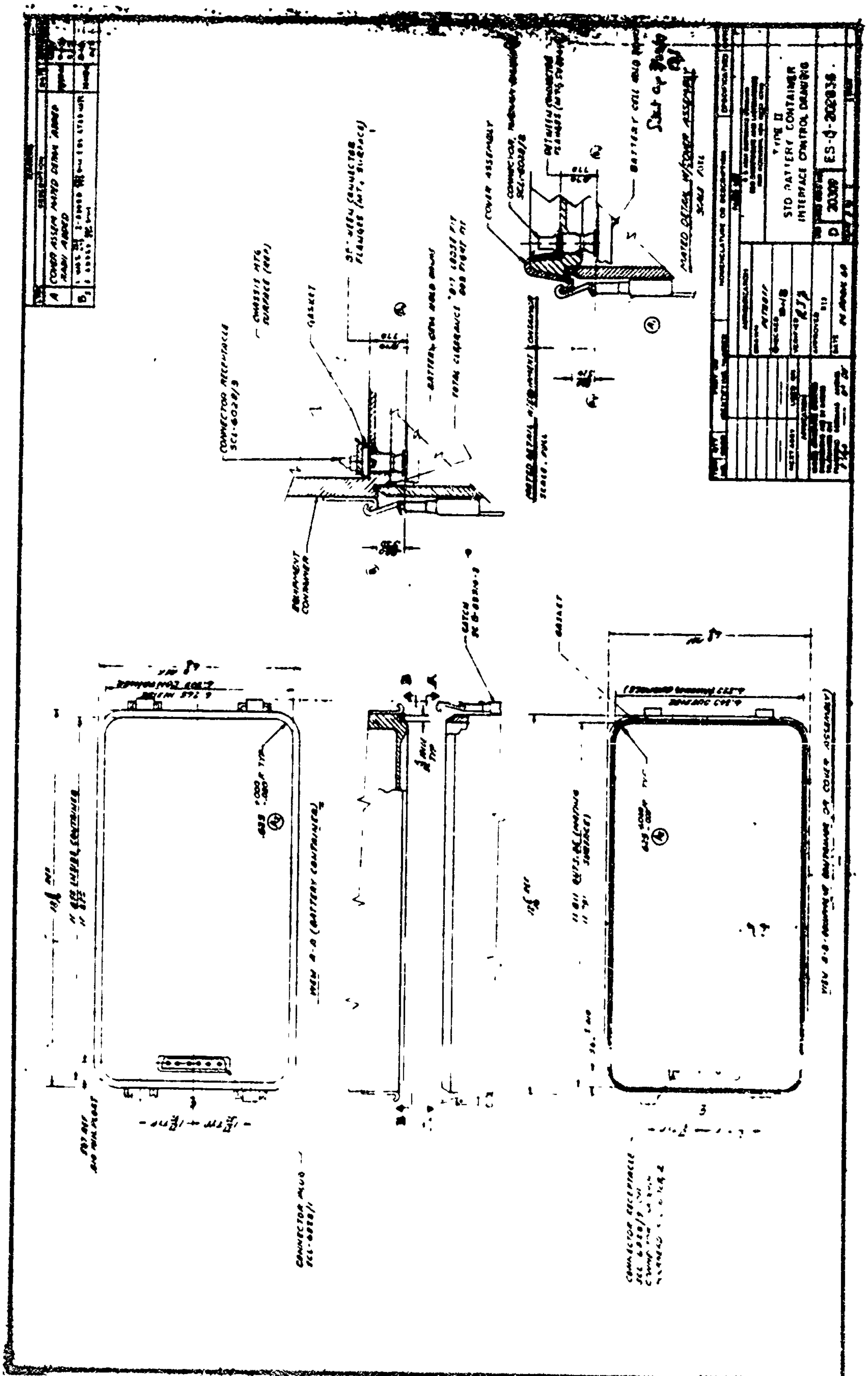


Fig. 5

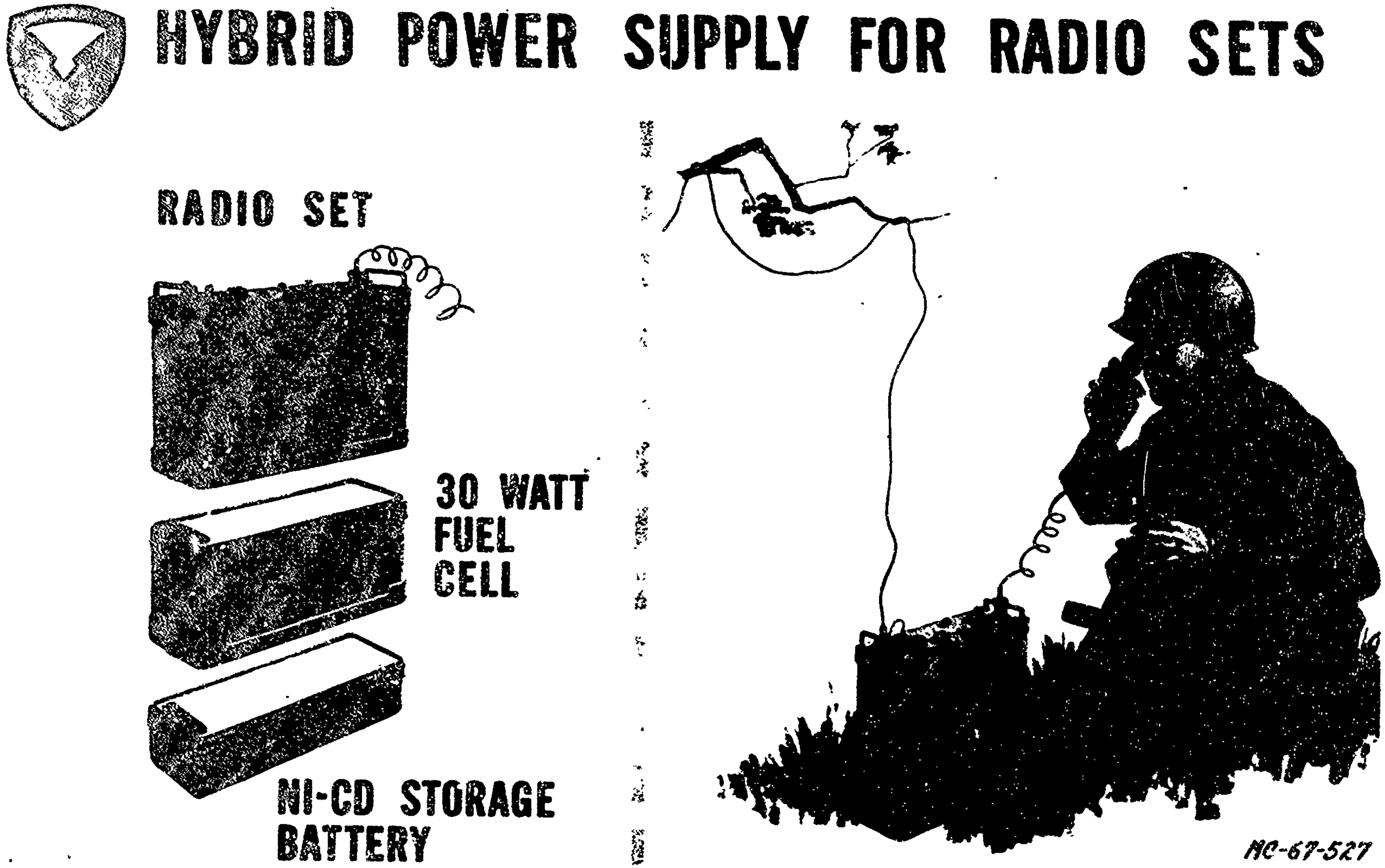

HYBRID POWER SUPPLY FOR RADIO SETS
RADIO SET
30 WATT
FUEL
CELL
NI-CD STORAGE
BATTERY
MC-67-527

Fig. 6

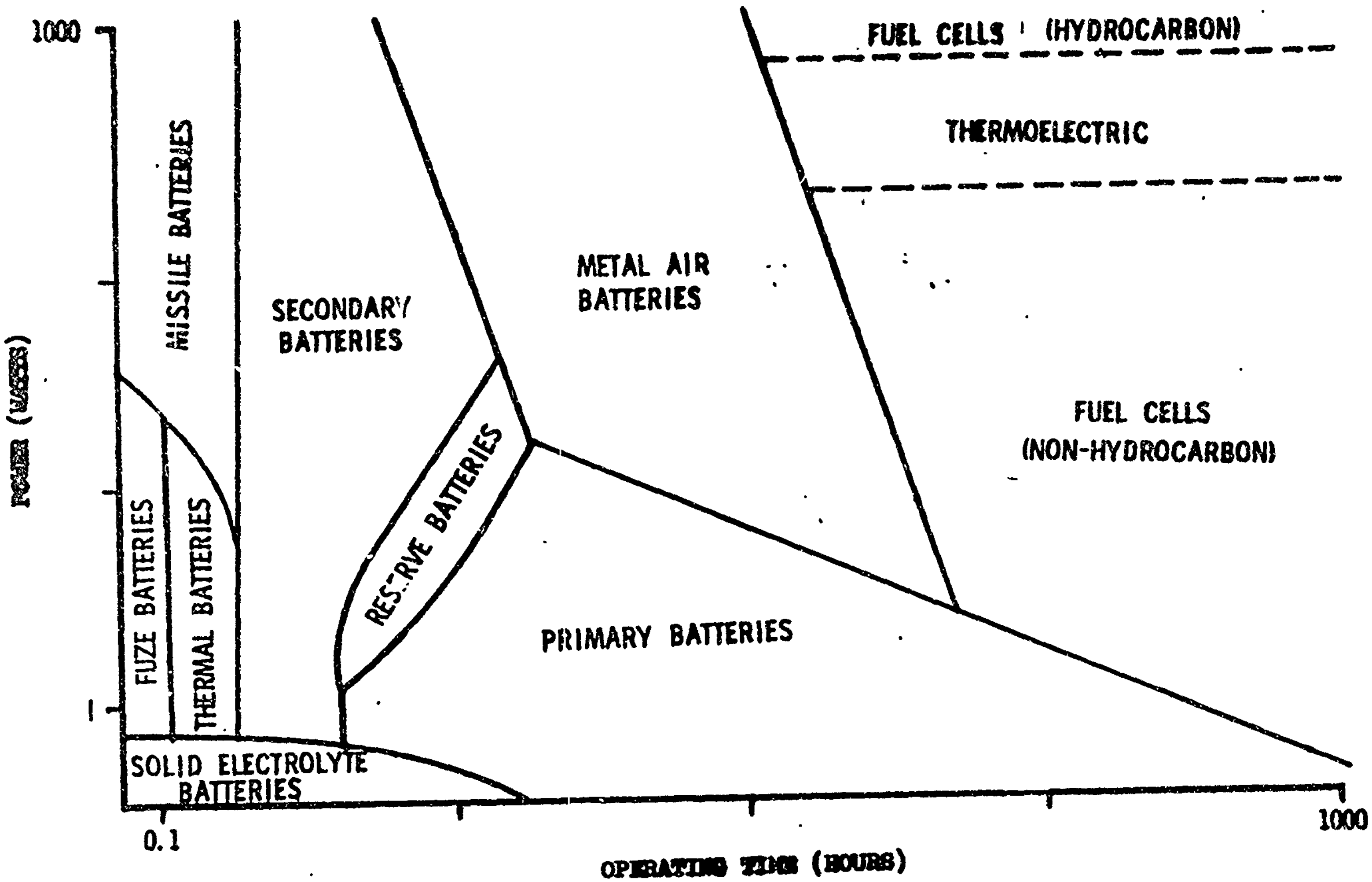

1000
1
POWER (WATTS)
0.1
1000
OPERATING TIME (HOURS)
FUZE BATTERIES
THERMAL BATTERIES
MISSILE BATTERIES
SOLID ELECTROLYTE BATTERIES
SECONDARY BATTERIES
RESERVE BATTERIES
METAL AIR BATTERIES
PRIMARY BATTERIES
FUEL CELLS (HYDROCARBON)
THERMOELECTRIC
FUEL CELLS (NON-HYDROCARBON)

Fig. 7

The general practice in the past has been to provide one type of power source for each equipment. This has not only resulted in a proliferation of power sources, but generally has resulted in a compromise in meeting all of the performance requirements. With the standard family, there is no longer a one-to-one relationship between power source and equipment. Rather, the user can select the power source that best meets the particular mission or use of the equipment and easily change the power source when the mission is changed. This "mission-orientation" provides the user with the best battery for his particular need and reduces the number of types as each power source has a multiplicity of applications.

Standard family power sources are being developed in the following systems. A listing of some of the types being developed and considered as a possible member of the standard family is given in Appendix A.

Primary Batteries

The standardization of the primary battery is illustrated with the development of the magnesium dry cell batteries BA-4520, BA-4521, BA-4840 and the alkaline battery BA-3840. All batteries provide the 12/24 volt selection through the standard 6 pin connector. The primary battery is housed and structurally protected by the user equipment. (Figure 3)

Secondary Batteries

The standard family of secondary batteries are available in both Type I and Type II configurations, in either 6, 6/12 or 12/24 volt combinations, and in the nickel-cadmium and zinc-silver oxide electrochemical system.[2] The nickel-cadmium system is noted for its reliable long-life performance; the zinc-silver oxide for its high energy density. The smaller size batteries are available in sealed cell construction.

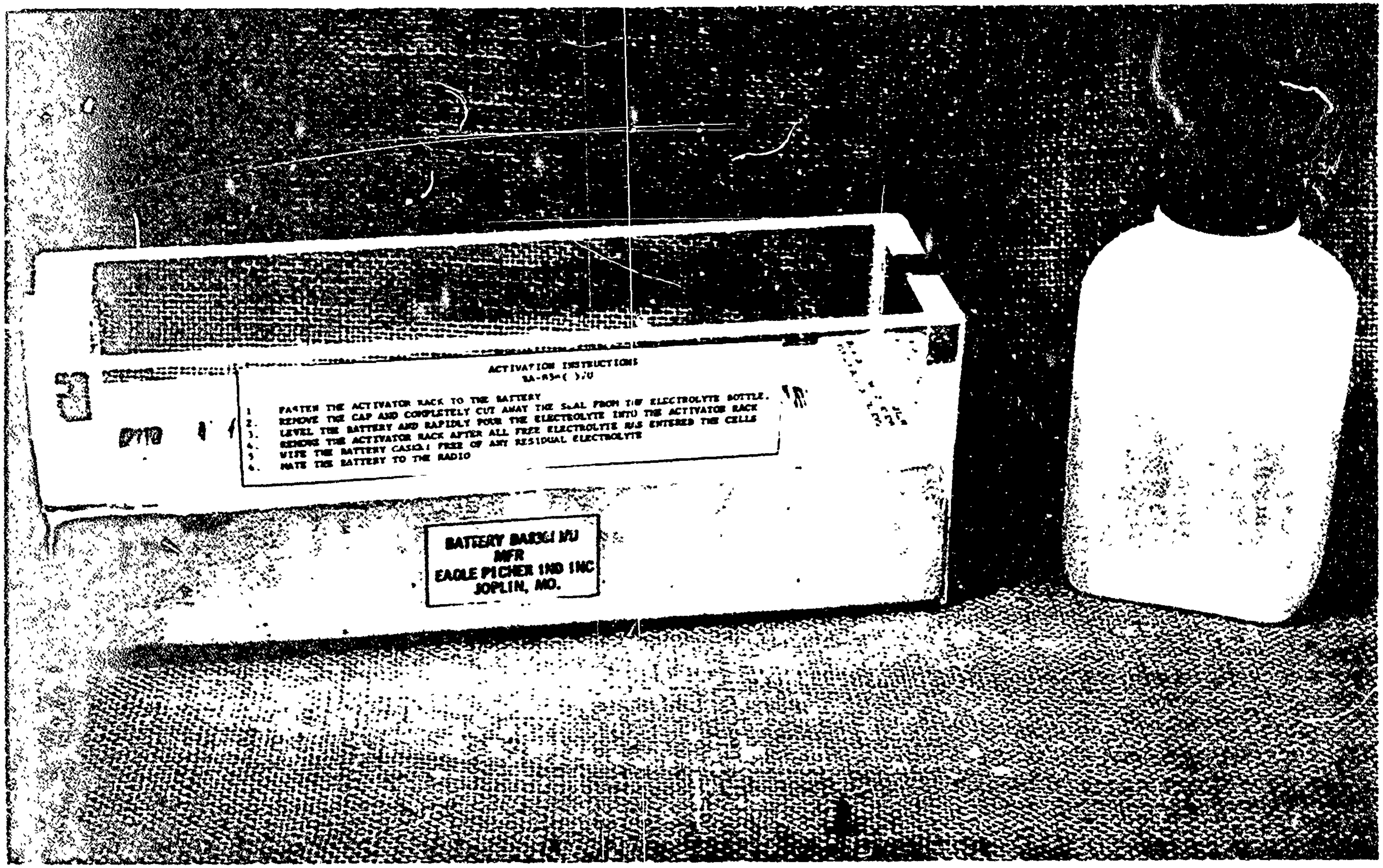
Reserve Batteries

The reserve batteries are specially designed batteries, which are usually very active, high energy systems. They are manufactured and stored in a dry state, without water or electrolyte, as in this condition they can have a long shelf life (once activated, their life is limited). Standard family reserve batteries have been designed using the magnesium perchlorate battery for low temperature use and the water-activated zinc-air battery, for light weight, high energy density (100 watthours/lb) operation of communication-electronic equipment.[3]

Figures 8 and 9 illustrate the Type I magnesium perchlorate battery with activator and water activated battery, respectively.

Metal-Air Batteries

The metal-air battery is mechanically rechargeable;[4] it is recharged by removing the discharged anodes, pouring water into the cells and reinserting new zinc anodes (See Figure 10). Recharging time is less than 10 minutes as opposed to hours for electrically rechargeable batteries. The mechanically rechargeable battery is also noted for its high energy density (80-100 watthours/lb).



BA-838( )/U BATTERY & ACTIVATOR

Fig. 8

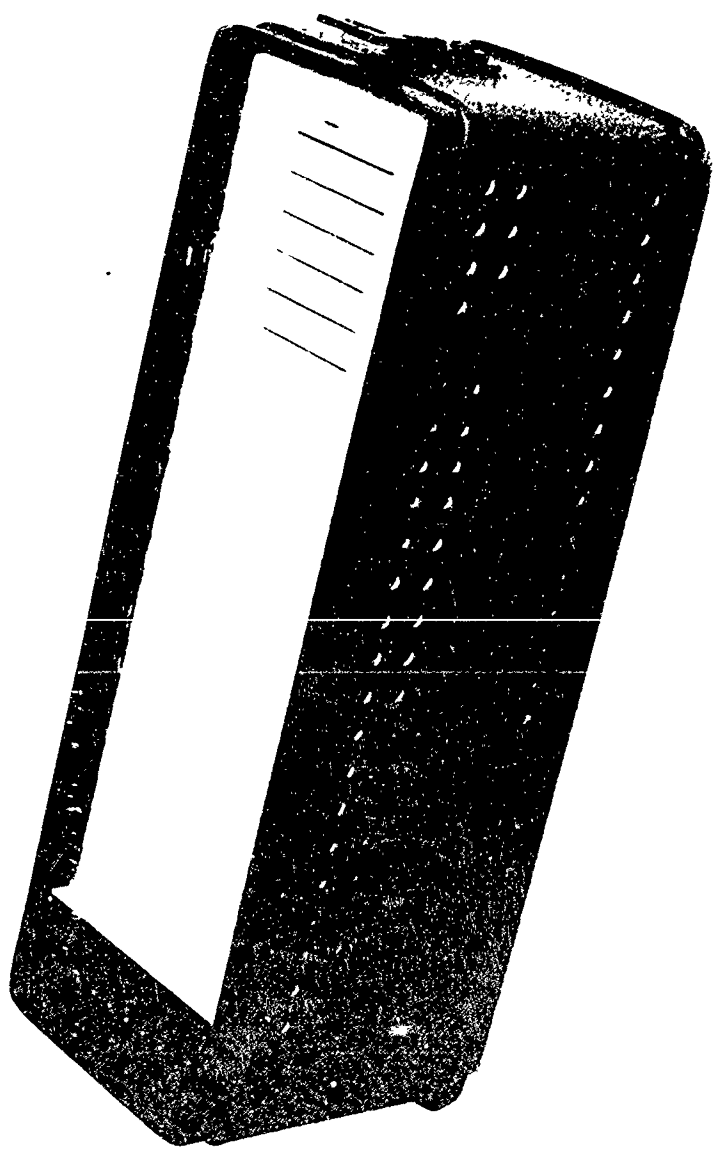


Fig. 9

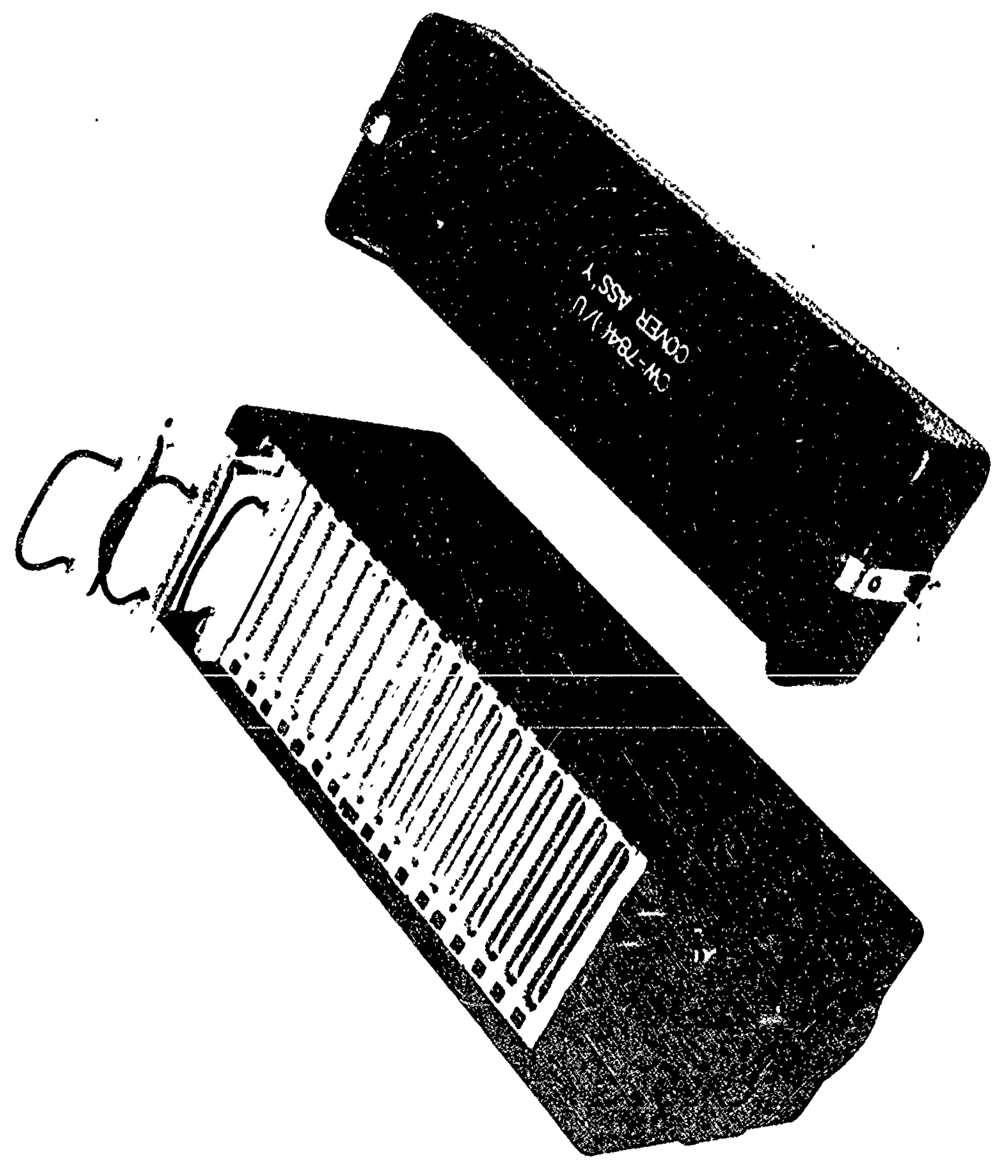


Fig. 10

The metal-air battery has been standardized in Type I and Type II configurations and with the standard receptacle in 6/12 or 12/24 volt outputs.

Fuel Cells

The fuel cell is a new electrochemical system, nearing completion of development, with the potential of yielding over 400 watthours/pound. Figure 11 illustrates the 60 watt-hydrazine fuel cell PP-6204 with a hybrid storage battery in a 24 volt design which provides a source of energy to start the fuel cell and handle peak power outputs. The 60 watt fuel cell is designed in the Type I configuration; various size batteries can be chosen for the hybrid depending on the peak power and energy requirements.[5] Larger, higher power fuel cells, using hydrazine or hydrocarbon fuels, are being designed. These units will have the standard output receptacle.

Thermoelectric Generator

The thermoelectric generator is the one silent power source now available for forward area field use that is capable of using all types of conventional liquid hydrocarbon fuels that are available in the field. Figure 12 illustrates PP-6335, a 60 watt unit in the Type I configuration. 10 A, 20 A and 30 A units (24 V) are also being designed with the standard output receptacle. They can be used both as power sources or as battery chargers.[6]

Battery Chargers and Power Supplies

Battery chargers and AC-DC power supplies have been designed to charge 6 - 24 volt batteries and to power equipments requiring either 12 - 16, or 24 - 32 volts DC. All battery chargers and power supplies under development requiring AC input voltages have been standardized to operate from 112/230 V and 50/60/400 Hz. High current power supplies from 25 A and above have been designed to be vehicle and rack mounted. Lower current power supplies are designed for vehicle mounting and for Type I or Type II configurations. An example of a Type I AC-DC power supply is shown in Figure 13.

Inverter

Sixty and 400 Hz static sine wave inverters have also been designed in the Type I and Type II standard configurations. The output characteristics of these inverters are regulated to provide an output voltage of 120 V AC $\pm 1\%$ at desired frequency $\pm 5\%$. The inverter is designed to operate from any of the batteries in the standard family.[7]

CONCLUSIONS

A standard family of power sources has been developed which offers the user a wide choice of power sources so he can select one most suitable to his mission. At the same time, this standard family by its use of a limited

Fig. 11

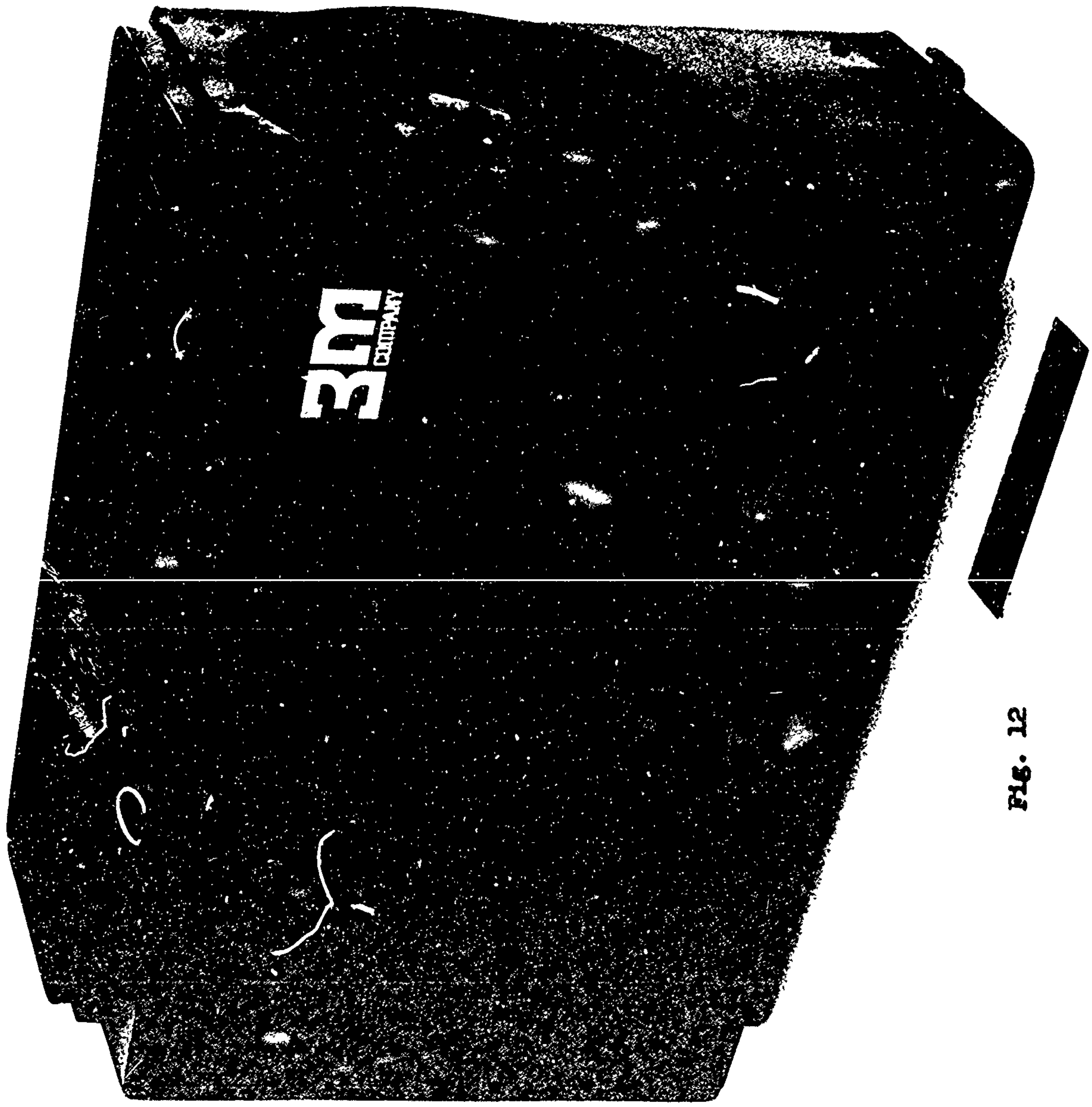


Fig. 12

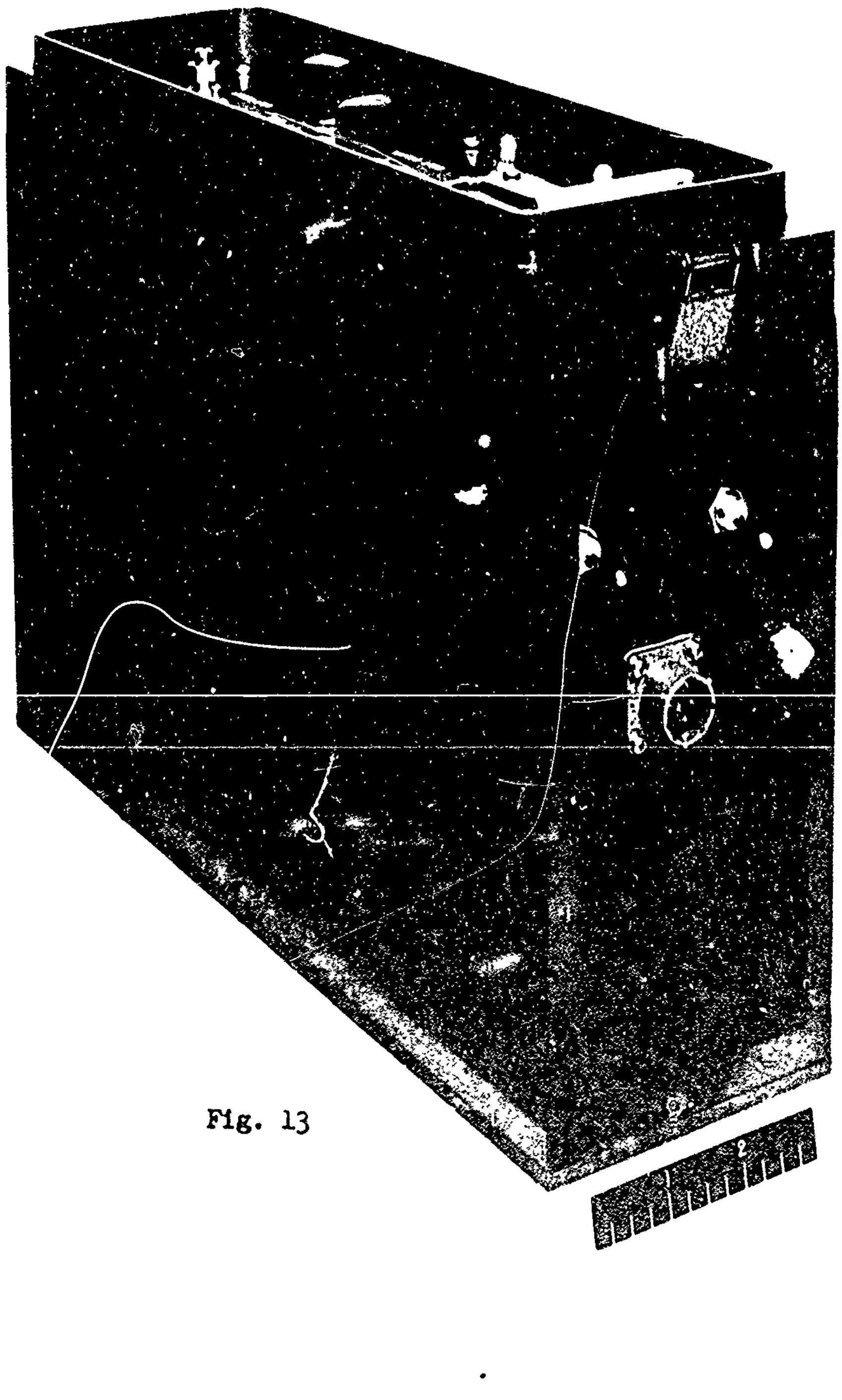


Fig. 13

number of output voltages, a standard connector/receptacle and other features enhancing interchangeability, significantly reduces the number of power sources required to support forward area applications, thereby simplifying logistics and reducing cost and development lead time.

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5. L. J. Rogers, "Hydrazine-Air (60/240 Watt) Manpack Fuel Cell," Proc. 23rd Annual Power Sources Conference, pp. 1-4, May 1969.

6. J. P. Angello, "Static, Silent, Thermoelectric Power Sources," Proc. 23rd Annual Power Sources Conference, pp. 165-168, May 1969.

7. W. L. Dudley, "Static Inverter for Lightweight, Silent DC-AC Field Power Source," Research and Development Technical Report ECOM-3171, September 1969.

APPENDIX A (See Note- Pg. 24)

(See Note- Pg. 24)

TYPE I MANPACK POWER SOURCES

SYSTEM	NOMENCLATURE	CAPACITY	VOLTS	WEIGHT (lbs)
Primary Batteries	BA-4521	3 W	12/24	1.4
	BA-4520	5 W	12/24	2.7
	BA-3840	15 Hrs With AN/PRC-70	12/24	14.5
	BA-4840	15 Hrs With AN/PRC-70	12/24	10
Secondary Batteries	BB-610	28/14 Ah	6/12	15
	BB-607	11/5.5 Ah	12/24	16
	BB-500	18/9 Ah	12/24	25
	BB-662	16/8 Ah	6/12	15
	BB-659	5.6/2.8 Ah	12/24	16
	BB-660	10.4/5.2 Ah	12/24	25
	BB-296	9/4.5 Ah	6/12	17.5
	BB-633	1.0/0.5 Ah	12/24	3
	BB-628	1.32/.66 Ah	12/24	5
	BB-629	2.0/1.0 Ah	12/24	6.5
	BB-630	4.3/2.15 Ah	12/24	10

SYSTEM	NOMENCLATURE	CAPACITY	VOLTS	WEIGHT (lbs)
Secondary Batteries (Cont)	BB-655	7.5/3.75 Ah	12/24	12
	BB-531	37.2/18.6 Ah	6/12	14
	BB-534	8/4 Ah	12/24	7
	BB-535	13.2/6.6 Ah	12/24	16
	BB-536	24/12 Ah	12/24	23.5
	BB-537	37.2/18.6 Ah	12/24	30
Reserve Batteries	BA-529	20/10 Ah	12/24	4
	BA-535	40/20 Ah	12/24	6
	BA-838	10/5 Ah	12/24	4
	BA-839	22/11 Ah	12/24	6
Metal Air Batteries	BA-524	80/40 Ah	6/12	7
	BA-525	40/20 Ah	12/24	7
	BA-526	64/32 Ah	12/24	10.2
	BA-527	96/48 Ah	12/24	15
Fuel Cells	PP-6203	30 W	12/24 (Nominal)	12.3
	PP-6204	60 W	24 (Nominal)	12

SYSTEM	NOMENCLATURE	CAPACITY	VOLTS	WEIGHT (lbs)
Power Supplies & Battery Chargers	PP-6148	10 A @ 24 V	12/24 (Nominal)	19
	PP-6355	3 A	24 (Nominal)	5
	PP-6348	250 VA	115 VAC 60/400 Hz	22
Thermoelectric Generators	PP-6333	60 W	6	20
	PP-6334	60 W	12	20
	PP-6335	60 W	28	20

TYPE II MAN-PORTABLE POWER SOURCES

SYSTEM	NOMENCLATURE	CAPACITY		VOLTS	WEIGHT (lbs)
Secondary Batteries	BB-501	28/14	Ah	12/24	30
	BB-487	11/5.5	Ah	12/24	17
	BB-661	16/11	Ah	12/24	30
	BB-539	160/80	Ah	12/24	40
Metal Air Battery	BA-528	300/150	Ah	12/24	35
Power Supplies & Battery Chargers	PP-6309	10	A	24	23
	PP-6310	15	A	24	23
	PP-6271	500	VA	115 (60/400 Hz)	30
	PP-6318	500	VA	115 (400 Hz)	25

OTHER CONFIGURATIONS

SYSTEM	NOMENCLATURE	CAPACITY		VOLTS	WEIGHT (lbs)
Secondary Battery	BB-294	12	Ah	6	6.7
Metal Air Battery	BA-537	20	Ah	12	4.5
Power Supplies & Battery Chargers	PP-6121	25	A	24	25
	PP-4126	450	W	12/24	36
	PP-4125	150	W	6/12	20
	PP-4127	6A & 6A		6 & 6	41

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This standard family incorporates the use of standard output voltages (6/12/24 volts), a standard connector which provides electric interchangeability and standard dimensions which provide physical interchangeability. The use of the standard family achieves a new concept in the deployment of power sources. No longer is a single power source developed for each equipment; rather, the selection of a battery is based on the mission requirement, the user selecting the most satisfactory battery for the particular deployment of his equipment.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Standard Connector						
Electrical Interchangeability						
Physical Interchangeability						
Type I Manpack Design						
Type II Man-Portable Design						
Hybrid Configuration						

ESC-FM ?120-7)